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The Effect of Antiseptic Treatments on the Control of Decay in Prepackaged and Bulk Peaches Stored at 70°F. for Ripening

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Introduction:

Consideration of the possible problems arising in prepackaging peaches led to the conclusion that it would be necessary to control brown rot and Rhizopus rot in the package. If this can be accomplished, firm ripe peaches may be prepackaged at the terminal market and held for ripening at the prevailing room temperatures. Thus ripe peaches with fewer bruises than those displayed in bushel or half bushel baskets would be available to the consumer. Peaches might also be prepackaged in a similar manner at the production points and ripened before displaying for retail in the stores. However, increased moisture in tight films would cause rapid development of brown rot and Rhizopus rot which would spread rapidly among peaches in a unit package. Refrigeration which could control decay would, however, prevent or retard ripening. Therefore, antiseptic treatment of the peaches prior to packaging, to control the development of brown rot, would be a necessary prerequisite for prepackaging green or firm ripe peaches.

Three tests were carried out to determine the effect of certain antiseptics on the development of decay in peaches. The first two tests were designed to determine the antiseptic value of Clorox on peaches in bulk. In the third test the peaches were prepackaged after the antiseptic treatments.

Effect of Clorox as Antiseptic on Bulk Peaches

Materials and Methods:

The peaches were obtained from the Plant Industry Farm at Beltsville, Md. in the morning soon after picking and brought to the handling room. The fruit was sorted into three groups, ripe, firm ripe, and green. Only the firm ripe fruits were used in these tests. The varieties were Hale Haven in Tests 1 and 2 and Elberta in Test 3.

Clorox was the antiseptic used in the first two tests. It is a sodium hypochlorite solution (NaCLO) which is listed as having 5.25% active ingredient. The active ingredient can be considered to be chlorine. Sodium thiosulfate starch-iodine titrations consistently gave the concentrated Clorox a value of approximately 59,000 p.p.m. of chlorine. The antiseptic action of the Clorox is probably due to its toxic and oxidizing properties which destroy the pathogens.

Dilutions were made to approximate the concentrations desired, using 50,000 p.p.m. an approximate figure, as the concentration of commercial Clorox. Solutions of approximately 1,000 p.p.m. 2,000 p.p.m., 5,000 p.p.m. and 10,000 p.p.m. were used in the first test. The effect of heat in conjunction with Clorox was tried using hot water from the tap to dilute the concentrated Clorox. The temperature of the hot water varied from 140°F. to 120°F.

The solutions were prepared in large porcelain tubs and hot water from the faucet was added to the calculated amount of Clorox to make 16 liters of solution as shown in table 1. The water temperature was taken before

Table 1.—Outline of antiseptic treatments of peaches in test 1.

and after immersion of the peaches, and the initial temperature is indicated for the treating temperatures.

Table 1.— Details of antiseptic treatments of peaches in test 1.

Lot	Average temp.	Dilution: Clorox	Dilution: H_2O	Approx. chlorine p.p.m.	Time of immersion	No. of fruit per replication	No. of replications	Total fruits
	°F.	Parts	Parts		Min.			
1A - Dry control	-	0		0	-	15	5	75
1B - Tap H_2O control	68	0		0	15	15	5	75
1C - " " "	140	0		0	15	15	5	75
1D - 1,200 p.p.m.	140	1	49	1600	15	15	5	75
1E - 2,000 p.p.m.	140	1	24	2000	15	15	5	75
1F - 5,000 p.p.m.	140	1	0	5000	15	15	5	75
1G - 10,000 p.p.m.	68	2	4	10000	15	15	1	15

Seventy-five fruits were used for each treatment except for treatments [illegible], and [illegible]. Since chlorine in solution is reduced during treatment, and since it was important to have no variation in treatment of the replicates, each lot of five tubs, representing the five replications, was made up to the proper concentrations and temperature and 15 peaches were immersed in each tub. The peaches were kept submerged for 15 minutes after which they were removed, and without rinsing were dried with towels. Each replication of 15 peaches was put in a small basket and placed at 70°F.

After four days at 70°F. the peaches were examined for decay and Clorox injury. The results are summarized in table [illegible].

Table [illegible]. — Effect of Clorox solution at 140°F. as an antiseptic on peaches treated when firm ripe and held 4 days at 70°F.

Table 1.--Effect of Clorox solution at 140°F. as an antiseptic on peaches treated when firm ripe and held 4 days at 70°F.

Lot	Application 1			Application 2			Application 3			Application 4			Application 5			Totals			Averages			Percent decayed	Percent injured
	Sound	Injured	Decayed	Sound	Injured	Decayed	Sound	Injured	Decayed	Sound	Injured	Decayed	Sound	Injured	Decayed	Sound	Injured	Decayed	Sound	Injured	Decayed		
1 Not any control	21	0	4	11	0	5	16	0	1	17	0	2	13	0	2	78		13	12.4		2.0	2.9	0
1 B Not control	11	0	4	8	0	6	12		4	-			-			32		15	10.7	0	5.0	32.4	0
1 C Not control 110°F.	8	0	0	2	0	13	14	0	1	3		5	8		7	39		26	7.8	0	7.4	16.0	0
1 D 100 p.p.m. 140°F.	7	6	2	3	6	3	8	4		Killed by heat. All 20 lbs.			6	7	4	28	23	29	7	5.75	2.25	15.	38
1 E 200 p.p.m. 140°F.	9	5	1	6	9	0	10	5	1	6	7	3	4	7	3	39	33	5	7.8	6.6	1	4.6	11
1 F 500 p.p.m. 140°F.		13	2	1	6	8		11	4		12	3	1	13	2	1	50	19	0.4	10.0	7.8	27.3	72
1 G 1,000 p.p.m. 68°F.	9	5	1		-			-			-			-		9	5	1		5	1	1.0	33

All Clorox concentrations used except 5,000 p.p.m. reduced the percentage of decay over the controls, and 2,000 p.p.m. and 10,000 p.p.m. of chlorine reduced decay very significantly. All fruits showing any speckling and discoloration of the skin are listed as injured. Many of the injuries caused by concentrations of 2,000 p.p.m. and 1,000 p.p.m. were very slight and the fruits would generally be saleable (acceptable). Injuries due to the higher concentrations used were severe enough to make the fruit unsaleable. Since the wet control at 140°F. did not show any injury and since 10,000 p.p.m. of chlorine at 68°F. showed less injury than any of the concentations at 140°F. injury is probably due to a combination of heat and chlorine. There was a higher percentage of decay in the wet controls than in the dry control, and the wet control at 140°F. showed a higher percentage of decay than the wet control at 68°F. These observations indicate that wetting causes an increase of decay, and furthermore that the increase is accelerated with rise in temperature.

One thousand p.p.m. of chlorine did not reduce decay to any appreciable extent over the dry control. Peaches treated with 5,000 p.p.m. of chlorine had more decay than the dry control and had an extremely high percentage of injured fruit. This indicates that the combination of 5,000 p.p.m. and water at 140°F. is actually harmful. Two thousand p.p.m. of Clorox proved to be the most satisfactory treatment tested.

In all the treatments with Clorox in which no injury occurred, color of the peaches appeared brighter.

In test 2 the same Clorox concentrations were used as in test 1, and an additional Clorox treatment of 3,000 p.p.m. was included. Tap water at 68° was used in making up all the solutions. The following treatments and concentrations were used:

Table 3.--Outline of antiseptic treatments of peaches in test 2.

Treatment	Dilutions		Approx. Cl_2 concentration	Time of immersion	No. of fruit per replication	No. of replications	Total fruit
	Clorox	H_2O					
	Parts	Parts		Minutes			
AControl dry	0	-	0	10	15	5	75
B " wet	0	-	0	10	15	5	75
C 1000 p.p.m.	1	49	1000 p.p.m.	10	15	5	75
D 2000 " " "	1	24	2000 p.p.m.	10	15	5	75
E 3000 " " "	1	15.6	3000 " " "	10	15	5	75
F 5000 " " "	1	9	5000 " " "	10	15	5	75
G 10000 p.p.m.	1	4	10000 " " "	10	15	5	75
							Total 525

The fruits were handled exactly as in test one except that only 10 minutes was allowed in the Clorox bath. After drying with towels, each replication was placed in a small basket, 15 peaches to a basket, and stored in the 70°F. room.

Examinations for decay and Clorox injury were made after two and four days of storage. The results are outlined in tables 4 and 5.

Table 4.— Effect of Clorox solution at 1:9 as an antiseptic on veneer treated when first cut and held for two days at 70°F. - Test No. 2

Lot and treatment	Replication 1			2			3			4			5			Totals			Average			Percent injured	Percent decay
	Sound	Injured	Decay	Sound	Injured	Decay	Sound	Injured	Decay	Sound	Injured	Decay	Sound	Injured	Decay	Sound	Injured	Decay	Sound	Injured	Decay		
A - Control dry	15	0	0	14	0	1	15	0	0	14	0	1	14	0	1	72	0	3	14.4	0	0.6	0	4
B - Control wet	14	0	1	14	0	1	14	0	1	14	0	1	14	0	1	70	0	5	14	0	1	0	6
C - 1:10 p.r.m.	15	0	0	14	0	0	14	0	1	14	0	1	15	0	0	72	0	2	14.4	0	.4	0	2
D - 1:9 p.r.m.	13	0	2	14	0	0	14	0	1	13	0	2	15	0	0	69	0	5	13.8	0	1.0	0	7
E - 1:8 p.r.m.	15	0	0	14 slight	0	0	15	0	0	15 slight	0	0	14	0	1	73	0	1	14.6	0	.2	0	1
F - 1:7 p.r.m.	14 slight	0	1	14 slight	0	1	14 slight	0	1	15	0	0	15 slight	0	0	72	0	3	14.4	0	.6	0	4
G - 1:6 p.r.m.	0	15	0	0	14	1	1	14	0	0	15	0	0	15	0	1	73	1	0.2	14.6	.2	97.3	1.3

Table 5.— Effect of Clorox solution at 68°F. as an antiseptic on peaches treated when firm ripe and held for four days at 70°F.

Test No. 2.

Lot and treatment	Replication															Total			Per replicate average			Percent Injured	Percent Decay
	1			2			3			4			5										
	Sound	Injured	Decay	Sound	Injured	Decay	Sound	Injured	Decay	Sound	Injured	Decay	Sound	Injured	Decay	Sound	Injured	Decay	Sound	Injured	Decay		
A - Control dry	11	0	4	5	0	10	11	0	4	1	0	14	7	0	8	35	0	40	7	0	8	0	53.33
B - Control wet	12	0	3	7	0	8	5	0	10	5	0	10	6	0	9	35	0	40	7	0	8	0	53.33
C - 1000 p.p.m.	12	0	3	11	0	4	10	0	5	8	0	7	15	0	0	56	0	19	11.2	0	3.8	0	25.33
D - 2000 p.p.m.	10	1	4	14	0	1	14	0	1	12	0	3	15	0	0	65	1	9	13	.2	1.8	1.4	12.0
E - 3000 p.p.m.	2	0	13	0	10	5	9	0	6	10	5	0	10	3	1	31	18	25	6.2	3.6	5.0	24.3	33.3
F - 5000 p.p.m.	10	4	1	8	6	1	9	5	1	9	3	3	9	6	0	45	24	6	13.8	4.8	1.2	32.0	8.0
G - 10000 p.p.m.	14	0	1	0	11	4	0	11	4	0	9	6	0	14	1	14	45	16	11.8	0	4.0	60.8	26.66

After two days at 70°F. there was comparatively little decay in any of the lots. The dry and wet controls had averages of 4 and 6 percent respectively and the lots treated with 1,000 and 2,000 p.p.m. of Cl_2 had averages of 3 percent and 4.5 percent. None of these lots had any injury. No decay occurred in lots treated with 3,000 and 5,000 p.p.m. of chlorine, and only 1.3 percent in the lot treated with 10,000 p.p.m. but all these treatments produced high percentages of injury. The injury to fruits in the 3,000 and 5,000 lots was generally slight and the fruits were considered acceptable. However, the injury produced by 10,000 p.p.m. was severe enough to make the fruits unattractive.

At this examination there was apparently insufficient time for the development of enough decay to adequately evaluate the different chlorine treatments.

After four days at 70°F. the fruit which had been treated with 2,000 p.p.m. of Cl_2 was the most acceptable. The controls had about 4.5 times more decay than this treated lot, and the amount of injury was negligible.

The lot treated with 3,000 p.p.m. of chlorine showed a much higher percentage of decay than the lots treated with 2,000 p.p.m. or 5,000 p.p.m. This appears incongruous but may be explained by the Rhizopus nests in replications 1 and 3 which greatly increased the percentage of decay. It is noted that the number of injured fruits rose markedly after 2,000 p.p.m. Injury to the fruits by 3,000 and 5,000 p.p.m. appeared slight and the peaches were judged saleable. However, the injured fruit in the 10,000 p.p.m. group were considered unsaleable.

In both tests, 2,000 parts per million of chlorine significantly reduced the percentage of decay over the controls. Concentrations of 3,000 p.p.m. and higher caused increased percentage of decay and increased injury to the peaches. In the first test, which included heat and Clorox, there was more than three times as much decay in the dry control as in the lot treated with 2,000 p.p.m. In the second test, the controls had about 4.5 times as much decay as was in the lot treated with 2,000 p.p.m. The Clorox solutions at tap temperature gave more satisfactory results than Clorox in hot water, (140°F.)

The most practical application of chlorine treatments of peaches after harvest would probably be in conjunction with precooling where peaches are cooled in refrigerated water (hydrocooling). The chlorine could readily be added to the water in the concentrations desired. This is essentially what is being done in the patented commercial process known as "stericooling".

Effect of Clorox and Potassium Metabisulfite ($K_2S_2O_5$) as Antiseptics on Peaches Prepackaged in Moisture Proof Cellophane and Cellulose Acetate

Elberta peaches grown on the Plant Industry Farm at Beltsville were harvested in the morning and brought to the handling room. The peaches were sorted into three groups, green, firm ripe, and ripe. Only the firm ripe fruits were prepackaged.

Eleven treatments were used in this test. The treatments included two types of antiseptics, used singly and in combination with each other and five controls. The following table (Table 6) summarizes the treatments and replications.

Table 6. — Treatments of Prepackaged Peaches

Lot and Treatment	Film *	Antiseptic	No. of pkgs. in replication	Replications
A - Control No wrap	None	None	2	5
A - Control Dry	C. A.	None	2	5
B - Control Dry	MSAT	None	2	5
C - Control Wet	C. A.	None	3	5
D - Control Wet	MSAT	None	3	5
E - $K_2S_2O_5$ only	C. A.	$K_2S_2O_5$	3	5
F - $K_2S_2O_5$ only	MSAT	$K_2S_2O_5$	3	5
G - Clorox only	C. A.	Cl_2 2500 p.p.m.	3	5
H - Clorox only	MSAT	Cl_2 2500 p.p.m.	3	5
I - Clorox + $K_2S_2O_5$	C. A.	$K_2S_2O_5$ 1 g Cl_2 2500 p.p.m.	3	5
J - Clorox + $K_2S_2O_5$	MSAT	$K_2S_2O_5$ 1 g Cl_2 2500 p.p.m.	3	5

* MSAT - Moisture proof cellophane with code designation of 300-MSAT-66
C. A. - Cellulose acetate, 100 gauge. A permeable film.

Potassium metabisulfite which releases SO_2 slowly was considered a possible effective fungistatic agent if the SO_2 vapors could be kept in constant contact with the pathogenic organisms. This was tested by sealing 1 gram of $K_2S_2O_5$ in a small MSAT cellophane or cellulose acetate envelope. The envelope contained many pin prick perforations and was attached with Scotch tape to the film used for overwrapping the packages. As a second antiseptic Clorox was used. Based on tests 1 and 2, 2500 p.p.m. of chlorine was chosen as the concentration to use in these tests. The procedure for treating with Clorox was essentially the same as in tests 1 and 2. The fruits were dipped for 10 minutes in tubs of the Clorox solutions and then dried with towels.

Eight peaches were placed in chip board trays and each package was overwrapped with either 300 MSAT 86 or cellulose acetate except the unwrapped control. Special care was taken to obtain as complete seals as possible. Three treatments contained two packages per replication while all other treatments contained 3 packages per replication. All treatments were replicated 5 times. Each package was weighed and then stored at 70°F.

Results:

After four days at 70°F. the peaches were examined for the following factors; weight loss, CO_2 and O_2 concentrations in the package atmosphere, odor, flavor, and decay. The CO_2 determinations were made with an Orsat gas analyzer and the O_2 determinations were made with a Beckman oxygen analyzer. The results are summarized in table 7.

Table 7. — Effect of Clorox and potassium meta-bisulfite on peaches packaged in 300-MSAT-86 cellophane and (120) cellulose acetate films and held four days at 70°F.

Lot and treatment	Average weight loss	Average CO_2	Average O_2	Odor	Flavor	Condition of fruit		
						Sound	Injured	Decay
	%	%	%			%	%	%
A - Control dry no wrap	8.9	-	-	normal	normal O.K.	61.25	0	38.75
A - Control dry C.A.	3.4	10.4	10.96	alcoholic aldehydic 10% normal	abnormal	51.25	0	48.75
B - Control dry MSAT	0.57	26.5	8.7	fermented alcoholic	"	81.25	0	18.75
C - Control wet C.A.	3.6	17.8	11.2	" "	"	25.00	0	75.00
D - Control wet MSAT	0.67	36.5	7.8	" "	"	43.54	10.00	46.46
E - $K_2S_2O_5$ Cell. Acet.	3.3	11.5	11.2	90% fermented alcoholic 10% normal	"	60.00	10.83	29.17
F - $K_2S_2O_5$ MSAT	0.62	33.2	8.1	Alcoholic fermented slight SO_2	"	66.66	20.00	13.34
G - Clorox 2500 p.p.m. C.A.	3.9	14.9	10.2	Alcoholic and fermented	"	75.61	15.00	9.39
H - Clorox 2500 p.p.m. MSAT	0.56	43.0	6.8	Alcoholic and fermented	"	53.33	42.50	4.17
I - Clorox 2500 p.p.m. + $K_2S_2O_5$ C.A.	3.9	12.8	11.6	95% fermented 5% normal	"	54.16	30.00	15.84
J - Clorox + $K_2S_2O_5$ MSAT	0.65	31.4	7.5	Fermented + SO_2 odor	"	38.33	51.66	10.01

The results clearly point out that Pliofilm, cellophane and cellulose acetate films, do not allow sufficient air exchange to prevent development of undesirable odors and flavors within the package. Cellulose acetate, which is a film quite permeable to water vapor and gases, still allows carbon dioxide to build up within the package to about 17 percent. This demonstrates that perforation is essential even with films of this type.

Weight Loss; O_2 and CO_2 in atmosphere:

Generally the non-wrapped controls lost about 3 percent, the cellulose acetate packages approximately 3.3 percent, and the Pliofilm group about 3.6 percent of the original weights. Only the unwrapped control appeared shrivelled and unsaleable.

The packages wrapped in cellulose acetate film had average concentrations of CO_2 ranging from 10 to 17 percent and of O_2 varying from 10 to 11 percent. The packages in Pliofilm had average CO_2 concentrations ranging from 8% to 13 percent and O_2 concentrations varying from 7.3 to 8.7 percent.

Odors and Flavors:

The results show that all the prepackaged lots were unsaleable on the basis of flavor and odor. Even in the packages wrapped in cellulose acetate there was an average accumulation of CO_2 varying between 10.4 and 17.3 percent accompanied by undesirable fermented odors and sour winey tastes in the peaches. A small percentage, about 5 to 10 percent, of the peaches in cellulose acetate films appeared normal and had a fairly good taste. The packages wrapped in Pliofilm had extremely high CO_2 percentages and the fruit had very strong abnormal odors.

Ripening and Decay:

Ripening of the peaches in the MSAT films was retarded, and many peaches were almost as green and hard as when they were first placed in the package. The effect of CO_2 in retarding the ripening of peaches has been demonstrated by a number of investigators and was to be expected from the high concentrations that were built up within the packages.

The tabulations in table 8 show the average differences in decay between the various treatments.

Table 8.— Combined total averages of the effect of film, antiseptic, wetting and packaging on percentage of decay.

The controls all had a very high incidence of decay ut the dry controls, (no dipping), had a much lower percentage of decay than the wet. The average total percentage of decay in all the controls was 45.5. In the non wrapped control 38.7 percent of the fruits were decayed and the average packaged controls had 47.2 percent decayed. The MSAT controls had a markedly lower percentage of decay than the cellulose acetate packages.

Table 8 also shows the apparent effect of CO_2 on the percentage of decay The fruit in packages with CO_2 above 26 percent, which included all the peaches packaged in MSAT films, showed only half as much decay as those packaged in cellulose acetate which had CO_2 percentages below 26.

When comparing the two films, the ratio of decay in C.A. to that in MSAT cellophane is approximately 2 to 1 whether or not the peaches have been treated with antiseptics. This difference is apparently due to the differences in carbon dioxide within the packages.

Table 5.— Combined total averages of the effect of film, antiseptic, wetting and packaging on percentage of decay.

Packaging and wetting		Film		Antiseptic	
Controls	Percent decay	Treatment	Percent decay	Treatment	Percent decay
Average of all	45.5	MSAT (high K_2)	13.1	None	45.5
Dry (non-wrapped)	39.7	M.A. (low K_2)	35.6	Average of all antiseptic treatment	17.6
Dry (wrapped + non-wrapped)	44.7	Antiseptic in soil	9.1	Clorox Only	6.7
Wet	50.7	Antiseptic in C. .	18.1	$K_2S_2O_5$ only	21.2
Wet and Dry (wrapped)	47.1	MSAT - control	39.6	Clorox + $K_2S_2O_5$	10.9
		M. A. - control	61.8		

Since CO_2 is present in the wrapped controls in concentrations approximately equal to those in the treated lots wrapped with the same films, the effect of CO_2 should be the same in both cases, and any differences observed in the fruits are due to the effect of the antiseptic used.

Of all the antiseptic treatments tried Clorox used alone was the most effective in preventing decay. Only 4.17 percent of the peaches treated with Clorox and wrapped with MSAT film decayed after 4 days at 70°F. (table 7). This is less than one-fourth of the amount of decay which occurred in the corresponding dry control (18.75 percent).

Potassium meta-bisulfite alone was not effective as an antiseptic and when used in combination with Clorox reduced the latter's effectiveness.

Injury was found with all antiseptic treatments and was much higher within the MSAT films than within the cellulose acetate films. As is shown in table 7, even the wet control in MSAT had 10 percent injury which was probably due to the high carbon dioxide concentration in the package. The treatment (2500 p.p.m. Cl_2 + MSAT) which had the lowest percentage of decay had 42.5 percent injury but the corresponding treatment in C.A. had only 15 percent injury. Injury within the cellulose acetate film was probably due to the antiseptics used, since the carbon dioxide in the control packages of this film caused no injury. The highest percentage of injury (51.6) of all the treatments occurred in the lot which was treated with Clorox plus potassium meta-bisulfite and wrapped in MSAT. This high injury was probably due to the combination of SO_2, chlorine and high CO_2.

Summary and Conclusions:

Chlorine as Clorox in concentrations of approximately 2000 - 2500 p.p.m. markedly reduced the percentage of decay in bulk and prepackaged firm ripe peaches, held at 70°F. for ripening. Decay in the controls varied in amount from 5 to 7 times that found in the Clorox treated peaches. These results are based on three tests in which each treatment was carried out in five replications of at least 15 peaches each.

The following table indicates the decay reduction in the three tests:

Table 9.— Comparison of control and Clorox treatments

		Percent decay	Difference control-decay	Ratio of decay : $\frac{\text{control}}{\text{treatment}}$
Test 1	Average controls	33.3	26.7	5 : 1
	2000 p.p.m.	6.6		
Test 2	Average controls	50.7	42.4	6 : 1
	2000 p.p.m.	8.3		
Test 3	Average controls	45.5	38.7	7 : 1
	2500 p.p.m.	6.7		

The treated peaches that were not injured had a brighter color as a result of dipping in Clorox solution.

Chlorine at 2000 parts per million or less, derived from Clorox solutions, produced no significant injury on peaches at tap water temperature (68°F.) but at a water temperature of 140°F., injury was produced by all concentrations tested (the lowest being 1000 p.p.m.).

Fruits treated with chlorine and sealed in MSAT cellophane or cellulose acetate had more injury than those treated with chlorine but not wrapped. Injury within the packages was accompanied by accumulations of CO_2; greater injury occurring within MSAT film, which held high concentrations of CO_2, than within cellulose acetate film, which retained relatively low concentrations.

Peaches are very sensitive to carbon dioxide, and should not be prepackaged in tightly sealed films. There is inadequate gas exchange through both MSAT cellophane and cellulose acetate films, resulting in an accumulation of carbon dioxide within the packages, and this is accompanied by development of off-odor and flavors. This work will be continued next year, using perforated films to avoid the effects of CO_2 on the fruit.